Entrepreneurial Human Capital

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April 24, 2009

Abstract

We argue that formal schooling and wage-work experience are complementary types of human capital for entrepreneurs. Strong empirical support is found for this hypothesis as the interaction term between schooling and actual wage-work experience enters positively and significantly in a Mincer equation, whereas the effect of schooling in the absence of wage-work experience is insignificant. These results are extremely robust towards more flexible specifications, including fixed-effects estimations dealing with unobserved heterogeneity. For wage workers, the interaction term is negligible, confirming that the complementarity is a distinct characteristic of entrepreneurial human capital.

Keywords: Schooling, experience, complementarity, entrepreneurs

JEL: I21, J24, J4

1 Introduction

What makes a successful entrepreneur? This question has been of great interest to both policy makers and researchers for a number of years. Both personal characteristics and the right framework conditions are believed to be important. In this paper, we focus on the former – the entrepreneurial human capital. Specifically, we consider the importance of formal schooling and labor market experience for entrepreneurial success as measured by earnings.

Lazear's (2004, 2005) "Jacks-of-all-trades" idea is that entrepreneurs are generalists as opposed to wage workers, who are specialists. In other words, a balanced set of skills is important for entrepreneurs, whereas wage workers can do or even fare better with specialized skills. Think of an IT-programmer. As a wage worker, he can specialize in programming, while as an entrepreneur, he must also know how to keep books, obtain funds, hire employees and market his product in addition to being a good programmer.

Building on this idea, we propose that a balanced skill set can be acquired by mixing years of formal schooling with years of wage-work experience. Our hypothesis is that entrepreneurs can better utilize the theoretical skills acquired in school if they also have practical skills from wage employment. As an entrepreneur, the IT-programmer will only get the full return from his education if he can also handle the day-to-day business. Such skills can be obtained in wage employment under supervision of other individuals or by observing how others perform the tasks. Hence, we expect a complementarity between years of formal schooling and years of wage-work experience in entrepreneurial human capital formation.

We test this hypothesis in the simplest possible way by estimating Mincer equations where we include an interaction term between schooling and wage-work experience. In the literature on returns to education for wage employed, schooling and experience have typically entered separately in the Mincer equation, which implies that they are treated as perfect substitutes in human capital formation; see, *e.g.*, Card (1999) and Heckman *et al.* (2003). Our hypothesis is that this specification is inadequate when it comes to the entrepreneurs.[1]

The Danish register data that we use are particularly well-suited for testing our hypoth-

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[1] A number of studies have analyzed returns to schooling in entrepreneurship using standard Mincer regressions, where entrepreneurship is typically measured by self-employment. These studies have recently been summarized in a meta analysis by van der Sluis *et al.* (2008), who find the return to a marginal year of schooling to be 6.1% on average. To the best of our knowledge, none of the studies in this literature have considered the complementarity between schooling and wage-work experience.

esis. The reason is that measures of labor market experience at the individual level are measures of *actual* wage-work experience; not *potential* labor market experience as typically used in the literature; see Card (1999). This is important as potential experience may include idle years as well as years in self-employment, and because some individuals may acquire wage-work experience while still in school.

Another advantage of the Danish data is that we can use two different definitions of entrepreneurs. Our first definition consists of the self-employed. This is the most commonly used definition in the literature. It can, however, be criticized for not capturing the owners/managers of incorporated firms; see Parker (2004). To accommodate this weakness, we also apply an alternative definition, namely, the wage-employed managers. Lazear (2005) also argues that self-employed and managers possess the same types of skills. Hence, it is reasonable to expect that a theory of entrepreneurial human capital applies to managers and self-employed alike. Another advantage of the second definition is that the income of managers is easier to measure as they are formally employed and therefore receive an observable wage.

To preview our results, we find that formal schooling and wage-work experience are indeed strong complements in determining entrepreneurial income. The interaction term is positive and significant. Interestingly, we find that for entrepreneurs, schooling *only* pays off in combination with wage-work experience. These results hold for both our definitions of entrepreneurs and imply that an entrepreneur with 10 years of wage-work experience earns approximately 30% more if he has 18 instead of 9 years of education. These results are extremely robust. For instance, the coefficient estimate on the interaction term is hardly affected by the use of more flexible specifications of the Mincer equation and the use of different subsamples. For regular employees, on the other hand, we find that the interaction term is negligible, which shows that the complementarity is not a general feature of the Danish labor market. Instead, the complementarity seems to be a distinctive characteristic of the way in which human capital is accumulated for entrepreneurs.

Our results also show that the complementarity betweeen schooling and wage-work experience holds for both managerial and non-managerial wage-work experience. As a consequence, managers may gain the relevant experience on the job. We also find a smaller complementarity between self-employment experience and schooling for the self-employed, but as we shall argue this may well reflect other things than human capital accumulation.

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Thus, the relevant practical skills seems to be acquired most effectively in wage work.

To account for potential endogeneity of schooling and wage-work experience due to unobserved heterogeneity, we also estimate our empirical model with individual fixed effects on a panel of managers. The coefficient on the interaction term is still identified in this case, as managers acquire additional wage-work experience each year. The estimated complementarity between schooling and experience from wage-work is remarkably robust towards this extension.

Finally, our results also show that measuring experience as actual wage-work experience instead of potential labor market experience is important. If we use the latter measure, as is typically done in the literature, the positive interaction effect between schooling and experience disappears and we are back to the conventional Mincer specification. Thus, by encompassing existing findings, our results appear to be of general relevance and not just a specific feature of the Danish entrepreneurs.

The rest of the paper is structured as follows. Section 2 outlines the empirical framework and the hypothesis to be tested. The data are presented in Section 3, while Section 4 contains the empirical results. Section 5 concludes.

2   Empirical Framework

What constitutes entrepreneurial human capital? In his much celebrated articles, Lazear (2004, 2005) proposed that entrepreneurs are generalists whereas wage workers are specialists. Using the cook as an example, he argued that a balanced set of skills is important for entrepreneurs:

> "Entrepreneurs perform many tasks. Consider the founder of a new small restaurant. In addition to being a good cook, the founder must be able to obtain funds, hire workers, choose location and decor, obtain food supplies at a reasonable cost, keep books and market the restaurant. Being a good cook is insufficient for success. In order to hire someone to perform the other tasks, it is necessary to have at least some basic knowledge of the outsourced area so that the right vendor decisions are made. As a consequence, entrepreneurs must be jacks-of-all-trades to some extent." (Lazear, 2004).

Consistent with his theory, Lazear found that for a group of Standford MBA's, the probability of becoming an entrepreneur increased with the number of prior roles in previous employment and with a more field-dispersed set of courses in the MBA program.

While Lazear thus focused on the different skills that individuals can acquire by holding different occupations or choosing different educational subjects, our idea is different. We suggest that entrepreneurs may obtain the required balanced skills by mixing formal schooling with wage-work experience. Furthermore, we focus on the importance of this for the success as an entrepreneur, rather than the choice of becoming an entrepreneur.

The cook thus acquires detailed knowledge of cooking as well as theoretical skills (such as reading and calculating) through his or her basic and vocational education. To be fully productive in entrepreneurship, these skills must be supplemented by practical knowledge about the day-to-day business of running a restaurant – skills that can be acquired by working as an employee in one. Another example is the biochemist who may become an expert in biochemistry at the university, while knowledge about running a successful biochemistry firm may come more easily by working in this business. In other words, skills acquired in school cannot be fully utilized until coupled with the right practical experience.

This line of thought leads us to formulate the following concrete hypothesis:

> *For entrepreneurs, formal schooling and wage-work experience constitute complementary types of human capital in income formation.*

For wage workers, on the other hand, formal schooling and wage-work experience should not constitute complementary types of human capital at the individual level. The productivity-enhancing effects of schooling can in this case be achieved without the individual herself having practical wage-work experience.

Furthermore, our hypothesis is that both non-managerial and managerial wage-work experience can complement formal schooling for the entrepeneurs, as the individual will acquire practical skills from working with other individuals in both cases. Self-employment experience, on the other hand, does often not provide that opportunity, as many self-employed work on their own. Hence, we do not expect the complementarity to apply for self-employment experience – at least not to the same extent.

We test the above hypothesis in the most direct and simple manner by estimating an extended Mincer equation of the following form:

$$\log(y) = \beta_0 + \beta_1 S + \beta_2 X + \beta_3 X^2 + \beta_4 SX + \beta_5 Z + e \tag{1}$$

where y is earnings, S represents formal schooling, X is wage-work experience, Z contains other controls, such as dummies for gender and location, and e is an error term. In some of the estimations, we also distinguish explicitly between managerial and non-managerial wage-work experience. According to the above hypothesis, we expect the coefficient, β_4, on the interaction term, SX, to be positive for entrepreneurs. This implies that the cross derivative of $\log(y)$ with respect to schooling and experience, $\partial^2 \log(y)/\partial S \partial X$, becomes positive for entrepreneurs. A higher level of experience will thus increase the (relative) effect of schooling on income, and *vice versa.*

In the standard Mincer equation, such an interaction term is not included (see, *e.g.*, Card, 1999; Heckman *et al.*, 2003):

$$\log(y) = b_0 + b_1 S + b_2 X + b_3 X^2 + b_5 Z + e \tag{2}$$

Hence, S and X are treated largely as perfect substitutes as the cross-derivative of $\log(y)$ with respect to S and X is zero in this case.[2] This is also the conventional approach in the literature estimating the effects of schooling in entrepreneurship; see van der Sluis *et al.* (2008).[3]

A large and growing literature is, however, concerned with heterogeneity in the returns to education across individuals in the sense that these returns may depend on factors such as school quality, family background and ability; see, *e.g.*, Card (1999, 2001) and Blundell and Costa Dias (forthcoming). We add to this approach by suggesting a somewhat different source of heterogeneity which is not related to time-invariant individual characteristics but

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[2] To be precise, X and S are not perfect substitutes as the squared term in X implies a decreasing rate of return to X. The theoretical justification for the specification in (2) was given by Mincer (1974), who assumed that after having completed school, individuals would spend a given share of their time in learning activities, thereby increasing their human capital as if they were still in school. Assuming that this share declines over time gives rise to the squared experience term, X^2, in (2).

[3] Mincer (1974) did in fact include an interaction term between schooling and experience in some of his original regressions for wage workers. He found a small negative coefficient to this term, which, however, disappeared when another income measure was used. Thus, his results seem to confirm that schooling and experience can rightly be treated as perfect substitutes for wage workers.

instead to the subsequent employment pattern of the entrepreneurs.

In most of the subsequent estimations of (1), we shall rely on OLS allowing for heteroscedasticity in the error terms. A general weakness of using OLS on (1) is that schooling, S (as well as experience, X), may be endogenous due to the presence of unobserved individual heterogeneity typically in the form of ability differences showing up in the error term. This problem has been repeatedly stressed in the literature on returns to schooling; see, *e.g.*, Griliches (1977) and Card (1999). Various instruments for S have also been proposed to overcome this problem, but the suggested instruments have been criticized for not being exogenous or for being too weak to offer credible inference; see Carneiro and Heckman (2002) and Heckman *et al.* (2003). Card (2001) also concludes that IV estimates are typically very imprecise, and hence do not offer decisive evidence about the potential ability bias in the OLS estimates. For these reasons, we choose OLS as our main method of estimation.

However, as we shall argue below, β_4, can also be identified in an individual fixed-effects estimation of (1) using a panel of the manager entrepreneurs, as SX grows over time for this group. This allows us to purge the estimate of β_4 from any bias/inconsistency resulting from unobserved individual heterogeneity, and hence provides a strong robustness check of the OLS results.

Finally, as our population of interest is the entrepreneurs, we do not try to correct for self-selection into entrepreneurship. Instead, our results should be interpreted as conditional on the choice of becoming an entrepreneur.

3   Data and Measurement Issues

Our data come from the Integrated Data Base for Labor Market Research ("IDA") compiled by Statistics Denmark and cover the period 1980-2002. These data contain register data for all individuals with Danish residency since 1980. The data provide detailed information on labor market performance, such as occupation, earnings and experience, as well as a wide range of individual characteristics like education and family background. For more information on the IDA data, see Abowd and Kramarz (1999).

In most of the estimations of (1), we use a cross section of individuals from the private (non-primary) sector in 2002, but we exploit the historical information in IDA to construct some of the explanatory variables, in particular the experience measures. For some of the

robustness checks, we use different sample years, and in one case, we even exploit the panel dimension of the data set as explained below.

There are three major measurement issues related to the estimation of (1): First, how to identify the entrepreneurs. Second, how to measure their income. And third, how to measure their human capital, *i.e.*, their schooling and wage-work experience. We shall discuss each of these issues in turn.

Regarding the first issue, we use two different definitions of entrepreneurs: Self-employed and managers. The former measure is the one most frequently used in the literature. However, it does not include an important class of entrepreneurs: the owners/managers of incorporated firms; see Parker (2004). As we can actually identify the set of managers among all wage workers from detailed occupational information on all workers, we use these as an alternative entrepreneurial group. In many of the incorporated firms, the managers will also be equivalent to the owners.

With respect to the self-employed, there are at least two data problems: (i) some individuals are both self-employed and wage employed at the same time; and (ii) a number of individuals change status during the year, and because we rely on annual observations, we have to determine whether or not such individuals should be included in the group of self-employed.

Our preferred definition of a self-employed individual is based on his or her primary occupation in the last week of November. This is the definition used by Statistics Denmark to determine the labor market status of individuals. As an alternative definition, we select the subset of self-employed who have employees. These self-employed are less likely to have switched in and out of self-employment during the year and are also less likely to hold additional jobs. Hence, they provide a more "stable" and homogeneous group of entrepreneurs.

The second measurement issue concerns how to measure entrepreneurial income. For managers, the solution is straightforward since we have detailed data on their wages. For self-employed, the problem is that we typically have different measures of the reported income, and that reported income need not perfectly reflect generated income; see Hamilton (2000). In this paper, we rely on a measure of the *annual surplus* from self-employment activities, which is comparable to the net profit measure used by Hamilton (2000). This is the amount reported to the tax authorities but it need not equal the amount withdrawn for personal

consumption.[4]

The third issue relates to the measurement of schooling, S, and experience, X. We measure schooling by years of formal education. The Danish educational system contains a variety of formal educational levels, including vocational education as well as short, medium and long further educational levels. Primary and lower secondary school correspond to 9 and 10 years of education, respectively, where 9 years is the mandatory level in Denmark. A high-school degree corresponds to 12 years. Vocational education is an alternative to high school with a typical duration of 3 years, resulting in a total of 12 years of education. The different education programs are managed by the public sector, which means that the quality and content are harmonized across schools. A high-school degree can be followed by further education. A long further education program corresponds to the Master or PhD level (18+ years of total education). Medium further education corresponds to the Bachelor level (16 years), whereas short further education is more practical and results in a total of 14 years.

Experience, X, is a measure of actual wage-work experience, which we construct from the historical information about labor market status for each individual since 1980. Hence, we do not rely on potential experience measured as "$age - S - 6$". Potential experience is the typical measure used in the literature, but it implicitly assumes that the individual started school at the age of six and began working right after school; not before. We stress this distinction because it is important for the results that we report below.

The availability of actual experience measures is also important as it allows us to distinguish between experience from wage employment and self-employment. Each year, we know whether individuals are wage employed, self-employed, non-employed, or unemployed. We use this to construct separate measures of experience in wage employment and self-employment.[5] This split is especially important for the present analysis as our theoretical hypothesis is that entrepreneurs learn from being employed with others. In other words, we expect the complementarity to arise between schooling and wage-work experience; not between schooling and self-employment experience (or at least only to a smaller degree).

Furthermore, self-employment experience is likely to capture other effects than human

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[4]Hamilton (2000) argues that non-pecuniary benefits are also likely to be important. But like most other studies, we have no possibilities to control for this aspect. However, it will not bias the estimates if these unmeasured benefits can be assumed to be proportional to the annual surplus.

[5]We also use an alternative measure of wage-employment experience, which converts years of wage-work experience into full-time equivalents; see Section 4.2.

capital accumulation. If self-employed invest in their firms when they are young and disinvest later on, this will create a positive correlation between the measured annual surplus and self-employment experience. Hence, even if we find a complementarity between schooling and self-employment experience, we cannot be sure that it reflects a human capital effect.

Since 1980 is the first year with register data on individuals, we limit our sample to include only individuals that were younger than 20 years in 1980. This choice excludes individuals with (extensive) job experience in already 1980. In other words, our sample consists of relatively young individuals, *i.e.*, younger than 42 years in 2002.

Using the above sampling requirements, and excluding individuals with negative earnings, results in two samples for 2002 with 34,485 self-employed (of which 14,177 have employees) and 13,095 managers, respectively.[6]

The distributions of schooling and experience for the 2002 samples of self-employed and managers are shown in Table 1.

<Table 1 about here>

It is seen that the majority of both self-employed and managers have 12 years of schooling, but that the distribution is skewed towards fewer years of education for self-employed and more years for managers. More interestingly, all groups of self-employed have around 10 years of wage-work experience on average. For managers, the average level is somewhat higher, but still relatively constant across education groups. This is in stark contrast to the amount of potential experience presented in the last column. Using this measure of experience, a strong negative correlation with years of schooling appears.

As controls in the estimations we use a range of socio-demographic variables, including age, gender, marital status, a dummy for living in a city, an immigrant dummy and a dummy for whether the spouse assists in the firm.[7] It is important to control for the latter variable when defining entrepreneurs as self-employed since an assisting spouse is likely to increase the annual surplus because the remuneration for this work is not (fully) deducted in the surplus. Summary statistics of all variables used in the empirical analysis are presented in Table 2.

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[6]Managers with previous self-employment experience have been excluded from the sample.

[7]Note that age can be included in the regressions together with S and X when X is measured as actual instead of potential experience.

<Table 2 about here>

4   Empirical Results

In this section, we present the results of our estimations. Section 4.1 contains the main results, Section 4.2 contains a number of robustness checks, and Section 4.3 presents results from estimations on non-managerial wage workers.

4.1   Main Results

Table 3 presents the results from the estimation of (1) for self-employed and managers, respectively. For both groups, estimations have been performed both with and without the interaction term between schooling and wage-work experience included. The table only contains the estimated coefficients for the variables of interest. A full set of estimation results can be found in Table A1 in the Appendix.

<Table 3 about here>

Two important things can be observed from the table. First, the interaction term is significantly positive for both managers and self-employed, which indicates that schooling and wage-work experience are indeed complements in human-capital formation for entrepreneurs. Moreover, the estimated coefficients are quantitatively of the same magnitude.

Second, the estimated coefficient to schooling becomes insignificant in both cases with the inclusion of the interaction term. Thus, not only do schooling and wage-work experience appear to complement each other for entrepreneurs, but there is also virtually no return to schooling in ´the absence of wage-work experience.

To illustrate the quantitative importance of these points, Figure 1 shows the estimated income-experience profiles for self-employed and managers with 9 and 18 years of schooling, respectively. The effect of schooling for self-employed is thus the vertical difference between the two curves for self-employed, and similarly for the managers.[8]

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[8]Note that the profiles for managers and self-employmed are not directly comparable due to the different income measures used for the two groups of entrepreneurs and the presence of different controls in the underlying regressions, *cf.* Table 3.

<Figure 1 about here>

The figure clearly illustrates how the effects of schooling kick in as individuals gain more experience from wage employment. While the estimated effect of schooling in the absence of wage-work experience (*i.e.*, when $X = 0$) is insignificant for both groups – and in fact negative for self-employed – a positive effect of schooling materializes for individuals with more wage-work experience. Thus, a self-employed with 10 years of wage-work experience earns 19.6% more with 18 instead of 9 years of schooling.[9] Similarly, managers with 10 years of experience earn 33.2% more with 18 instead of 9 years of schooling. The difference between managers and self-employed is due to the small negative and insignificant coefficient to S (schooling) in the case of self-employed. Ignoring this term, the effects would be around 30% for both groups. In sum, these results bear evidence of a strong complementarity between formal schooling and wage-work experience for both types of entrepreneurs.

To analyze the importance of using actual wage-work experience instead of potential experience, we reestimate (1) for self-employed and managers using potential experience as defined in Section 3. The results of this exercise are shown in Table 4.

<Table 4 about here>

The interaction effect disappears for self-employed and actually becomes negative for managers in this case. Note also that the estimated coefficients on S and X become much higher than in Table 3, and the coefficient to S is now also significant. The larger effect of potential experience (in particular for the self-employed) is fully as expected from our discussion in the previous section. Here we argued that a positive correlation will exist between self-employment earnings and years spent in self-employment because it takes some years to get a business running, and because earnings in the first years are often reinvested in the business. This effect tends to decrease initial earnings, thereby resulting in a seemingly steeper earnings-experience profile.

The fact that the positive interaction terms disappear when using potential experience may explain why existing studies of returns to schooling in entrepreneurship – which typically rely on potential experience – have not discovered the apparent complementarity between schooling and wage-work experience.

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[9]The difference in earnings is calculated as the exponential of the difference in log earnings minus 1.

4.2 Robustness Checks

Above we found a positive interaction effect between schooling and wage-work experience for managers and self-employed. In this section, we present a number of robustness checks of this result.

4.2.1 Alternative Specifications and Samples

First, a potential problem is that the significant coefficient on the interaction term may pick up omitted higher order terms in schooling and/or wage-work experience rather than a complementarity between the two. To check whether this is the case, we re-estimate (1) including terms of X and S raised to the power of 2, 3 and 4. The results of this exercise are shown in columns 2 and 3 of Table 5 below.

As can be seen, the inclusion of these extra terms does not affect the size of the coefficient to SX qualitatively. In fact, the estimate of around 0.003 is remarkably robust towards these changes in the specification for both managers and self-employed.

<Table 5 about here>

As a final check on the importance of omitted higher order terms in S and X, we allow for a completely flexible specification in column 4 of Table 5. Here the variables S and X in (1) have been replaced by dummies for different levels of schooling and wage-work experience. Still, a coefficient of around 0.003 on SX prevails. Hence, it can be concluded that the positive interaction effect does not reflect separate non-linear effects of schooling and wage-work experience.

Second, another potential problem may be the inclusion of all individuals aged 20 or younger in 1980 in our samples. As some individuals gain considerable wage-work experience before the age of 20, and since we can only measure experience from 1980 and onwards, we may end up with biased measures of wage-work experience. This can potentially distort our results. To deal with this possibility, we re-estimate (1) restricting our samples to individuals aged 15 years or younger in 1980, assuming that experience gained before the age of 15 is negligible. The results from these estimations are reported in column 5 of Table 5. Restricting the samples in this way only has marginal effects on the parameter estimates, despite the fact that both sample sizes are cut by around 40%.

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Third, as measures of self-employment experience and wage-work experience are constructed from annual observations of individuals in the Danish labor market ignoring experience obtained abroad, the experience measures for immigrants may be inappropriate. If an immigrant arrives in Denmark in, say, 1992, she can at most have 10 years of recorded wage-work experience in 2002. This only constitutes a problem, however, if the experience gained before arrival is relevant for entrepreneurial earnings in Denmark. To check whether this affects our results, we re-estimate the model for self-employed and managers dropping all immigrants from the samples. As can be seen from column 6 in Table 5, this has only a minor influence on the estimates.

Fourth, as mentioned in Section 3, a more stable sample of self-employed can be obtained by focussing on those with employees. These self-employed are less likely to have switched in and out of self-employment during the year and are also less likely to hold additional jobs. Hence, their annual earnings are more likely to reflect the income from a full year in self-employment. Columns 7 and 8 therefore split the sample of self-employed into employers and non-employers. As the table shows, the order of magnitude of the estimated coefficient to the interaction term is the same in both cases.

Finally, a potential problem with the measure of wage-work experience used above is that a year of part-time employment counts as a full year of wage-work experience. This is reasonable if experience is not so much about the time spent in the job as the time spent as an employee. However, it can also be argued that experience should be calculated in full-time equivalents such that a part-time position counts less than full-time employment.

From data on wage earners' supplementary pension schemes, we are able to construct a measure of experience in wage-employment in full-time equivalents. Because these payments follow the individual's number of working hours, we use these to scale experience in wage-employment. The results from using this alternative measure of wage-work experience are presented in column 9 of Table 5. Again, the estimate for self-employed is unaffected, while the coefficient for managers drops to 0.0012. The latter result may reflect that it is not the effective time spent in wage employment but rather the number of years being wage employed that matters for this group.[10]

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[10]A data problem with the full-time equivalent experience measure is that the maximum number of hours worked follows the normal work week in the Danish labor market. This implies that nobody is registered to work more than 37 hours per week. This restriction reduces the quality of the experience measure especially for managers since survey data suggest that a high share of managers work more than "full time" (37 hours).

Another robustness check on our main result is performed in Table 6. Here we include results using a different sample year, 1998. This reduces sample sizes somewhat since the oldest individuals in the sample are now 38 years. The estimated coefficients are, however, relatively robust towards these changes. The interaction term thus remains significant and in fact becomes quantitatively more important for self-employed in 1998. For managers, the 95% confidence intervals for the two years overlap. We also ran the regressions for the years 1999, 2000 and 2001 and found that the interaction term enters positively and significantly. Results are available upon request.

<Table 6 about here>

4.2.2 Alternative Interaction Effects

Our hypothesis was that practical skills acquired through wage-work experience complement the theoretical skills acquired through formal schooling. Wage-work experience, however, includes both managerial and non-managerial experience. A relevant question is therefore whether the practical skills required to benefit from a theoretical education program are acquired most efficiently from working under others, *i.e.*, non-managerial experience, or from working with others as a manager.

Table 7 tries to answer this question by first excluding managerial wage-work experience from the measure of wage-work experience (column 2). This does not affect the estimated coefficients to the interaction term. In column 3, managerial experience is then included along with non-managerial experience and two interaction effects are then estimated. The results reveal that the interaction term between schooling and non-managerial experience is hardly affected, while the interaction term between schooling and managerial experience also becomes significant. Quantitatively, the effect of managerial wage-work experience is slightly smaller, but not significantly so which can be inferred from the included F-statistic. For the self-employed, we find similar results. The only difference is that the interaction term between schooling and managerial experience is insignificant, which is likely to reflect that managerial experience is relatively rare among the self-employed. In the sample only two percent of the self-employed have managerial experience, with a sample mean of 0.4 years.

Thus, the results presented in column 9 of Table 5 should be interpreted with caution.

In sum, it seems as if the practical skills acquired in wage-work experience can be obtained both as a manager and as a regular employee. An implication of this is that the managers may, so to speak, acquire the relevant experience on the job.

In relation to this, it seems natural to ask whether the self-employed may also acquire the relevant practical skills on the job, *i.e.*, while self-employed – in which case it would be general work experience rather than wage-work experience that matters. The last column of Table 7 therefore includes an interaction term between self-employment experience and schooling. As argued above, caution should be exercised when interpreting this coefficient as self-employment experience may reflect a number of other things than human capital accumulation.

Still, the inclusion of this interaction term only marginally affects the interaction term between wage-work experience and schooling. The interaction term between self-employment experience and schooling is also positive but significantly smaller than the interaction term between schooling and wage-work experience, cf. F-test. Thus, these results seem to confirm the hypothesis that the practical skills required to benefit from formal schooling are acquired most effectively in wage-work employment and not in self-employment.

<Table 7 about here>

4.2.3   Fixed Effects Results

As discussed in Section 2, the schooling variable, S, may be endogenous due to the presence of unobserved differences in ability across individuals which will create a correlation between S and the error term in (1). The typical argument is that more able individuals will both earn more and choose more schooling. Hence, the estimated effect of schooling may (partly) reflect an unobserved ability effect. Following the same lines of reasoning, there may also be endogeneity problems with wage-work experience, X, since more able individuals may need less time in wage work to absorb the relevant practical knowledge.

We can, however, check the importance of unobserved ability bias for our results by exploiting that, for managers, SX grows differently over time across individuals, as the annual increases in SX are different for individuals with different schooling levels. Hence, we can re-estimate (1) on a panel of managers using a fixed-effects estimation to eliminate unobserved (time-invariant) individual effects. The results of this exercise are presented in

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Table 8. The panel used covers the years 1996-2002 with the same restrictions as in the case of the cross section from 2002. Hence, we consider only individuals younger than 20 years in 1980 with no prior self-employment experience.

<Table 8 about here>

The coefficients to the interaction term presented in columns 2 and 3 of the table show that the complementarity between schooling and wage-work experience remains significant under this estimation approach.[11] In fact, we find a significant effect of quantitatively the same magnitude as in the previous tables. This provides a strong indication that the OLS estimates do not suffer seriously from an omitted variable bias.

4.3 Wage Workers

To analyze whether the discovered complementarity between schooling and wage-work experience is just a feature of the entrepreneurs or a more general feature of human capital formation, Table 9 shows the results from estimating (1) for wage workers (excluding managers).[12] In this case, the estimated coefficient to the interaction term becomes significantly negative as shown in column 2. This indicates that schooling and experience are – if anything – competing inputs into human capital formation for wage workers.

<Table 9 about here>

The relative importance of this finding is, however, much smaller than in the case of the entrepreneurs above. First, the partial effect of schooling when $X = 0$ is now significantly positive and sizeable. Second, and more importantly, the size of the negative interaction term is not robust to a more flexible specification using dummies for different levels of S

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[11]Note that in the first two columns of Table 8, the coefficient to schooling is identified only from the relatively few individuals changing their level of schooling between 1996 and 2002. These individuals are therefore dropped from the sample in column 3. Similarly, the coefficient to wage-work experience is only identified from individuals with multiple spells as managers in the panel. Hence, we do not wish to push the interpretation of these coefficients too far.

[12]We have restricted the sample to exclude workers with self-employment experience, implying that wage-work experience equals total experience.

and X as shown in column 3 of Table 9. In this case, the point estimate of the coefficient to the interaction term is only -0.0004. With 10 years of experience ($X = 10$), the interaction term thus amounts to a negative effect on income of only 3.7% from having 18 instead of 9 years of schooling. This effect is by far outweighed by the estimated partial effects of the schooling dummies (not shown in the table), which imply an income effect of 70% from 18 instead of 9 years of schooling.

In sum, even though the interaction term is negative and statistically significant for wage workers, its economic significance can for most purposes be disregarded. In other words, the standard Mincer equation in (2), where schooling and work experience are treated as perfect substitutes, seems appropriate for wage workers.

5   Conclusion

In this paper, we have tested the hypothesis that schooling and wage-work experience are complementary types of human capital for entrepreneurs. Using two different measures of entrepreneurs – self-employed and managers – we have found strong empirical support for this hypothesis as the interaction term between schooling and actual wage-work experience enters positively and significantly in a Mincer equation, whereas the partial effect of schooling in the absence of wage-work experience is insignificant. These findings are extremely robust towards changes in the samples, refinements of the experience measure used, and more flexible specifications, including fixed-effects estimations to deal with unobserved individual differences.

For wage-workers, on the other hand, the interaction term is negligible, suggesting that the discovered complementarity is a distinct characteristic of entrepreneurial human capital. Furthermore, our results show that measuring experience as actual wage-work experience instead of potential experience is important. Using potential labor market experience instead, the complementarity between schooling and experience disappears for the entrepreneurs.

The two latter findings strongly suggest that our results do not reflect a particular feature of the Danish data or the Danish entrepreneurs. They encompass existing studies by showing that a standard Mincer specification without an interaction term is applicable when (i) studying the return to education in wage employment; and (ii) studying entrepreneurs using potential experience as a proxy for actual experience.

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Our findings suggest that practical skills acquired in wage work are important for entrepreneurs if they are to benefit fully from the more theoretical skills acquired in school. The more precise nature of these practical skills is still an open issue. Exactly which skills are acquired by working with others that are so useful in entrepreneurship? And can some of these be learned in school if education programs become increasingly targeted towards entrepreneurship? We leave these questions for future research.

A   Detailed Estimation Results

This appendix contains the full set of estimation results from the regressions in Tables 3, 4 and 8 in the paper.

<Table A1 about here>.

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Table 1: Schooling and Labor Market Experience of Entrepreneurs, 2002

Years of schooling	Self-Employed				
	Share of individuals	Years of experience	of which wage worker	of which self-employed	Years of potential experience
9	14.6%	13.9	8.5	5.4	18.9
10	9.8%	14.5	9.2	5.4	17.0
12	59.7%	16.6	11.2	5.4	16.3
14	5.6%	15.5	10.9	4.6	14.6
16	6.6%	13.9	9.7	4.2	12.6
18	3.6%	14.6	10.2	4.4	12.1
All		15.7	10.5	5.2	16.3

Years of schooling	Managers				
	Share of individuals	Years of experience	of which wage worker	of which self-employed	Years of potential experience
9	2.7%	17.1	17.1	0	19.0
10	3.8%	16.5	16.6	0	17.4
12	52.2%	17.4	17.4	0	15.9
14	9.0%	17.0	17.0	0	14.3
16	17.8%	18.0	18.0	0	13.3
18	14.6%	16.7	16.7	0	12.2
All		17.3	17.3	0	15.0

Note: The samples include all self-employed and managers that were younger than 42 years in 2002 and active in the non-primary private sector.

Table 2: Summary Statistics, 2002

	Self-Employed				Managers			
	Mean	Std. Dev	Min	Max	Mean	Std. Dev	Min	Max
Log(Earnings)	12.096	1.188	0.693	16.559	12.944	0.515	6.620	16.290
Wage-work experience (in years)	10.471	5.219	0	22	17.330	4.617	1	23
Self-employment experience (in years)	5.240	3.992	1	23	0	0	0	0
Schooling (in years)	11.959	2.072	9	18	13.610	2.499	9	18
Age (in years)	34.239	4.993	15	41	34.655	4.781	15	41
Male (dummy)	0.780	0.414	0	1	0.768	0.422	0	1
Married (dummy)	0.741	0.438	0	1	0.816	0.388	0	1
City (dummy)	0.702	0.458	0	1	0.777	0.416	0	1
Immigrant (dummy)	0.117	0.321	0	1	0.019	0.137	0	1
Assisting spouse (dummy)	0.019	0.136	0	1	0	0	0	0

Note: The samples include all self-employed and managers that were younger than 42 years in 2002 and active in the non-primary private sector.

Table 3: Effects of Schooling and Wage-Work Experience for Entrepreneurs

	(1)	(2)	(3)	(4)
	Self-Employed		Managers	
Schooling (in years)	0.019**	-0.012	0.0521**	0.005
	0.003	*0.007*	*0.002*	*0.008*
Wage-work experience (in years)	0.128**	0.091**	0.084**	0.048**
	0.005	*0.008*	*0.007*	*0.009*
Wage-work experience squared	-0.003**	-0.003**	-0.002**	-0.002**
	0.000	*0.000*	*0.000*	*0.000*
Schooling * Wage-work experience	-	0.0032**	-	0.0027**
	-	*0.0006*	-	*0.0004*
Number of observations	34,485	34,485	13,095	13,095
R^2	0.1899	0.1908	0.3763	0.3796

Notes: The dependent variables used are: Annual surplus (for self-employed) and total wage income (for managers). The regressions include the following variables as additional controls: Age (in years), male (dummy), married (dummy), city (dummy), and immigrant (dummy). Columns (1) and (2) also include a dummy for an assisting spouse and years of self-employment experience. A full set of estimation results can be found in Table A1 in the Appendix. Robust standard errors in italics. ** = significant at 1% level; * = significant at 5% level.

Table 4: Effects of Schooling and Potential Experience for Entrepreneurs

	(1)	(2)	(3)	(4)
	Self-employed		Managers	
Schooling (in years)	0.039**	0.041**	0.0846**	0.102**
	0.003	*0.012*	*0.002*	*0.007*
Potential experience (in years)	0.191**	0.193**	0.110**	0.135**
	0.007	*0.014*	*0.005*	*0.010*
Potential experience squared	-0.005**	-0.005**	-0.002**	-0.003**
	0.000	*0.000*	*0.000*	*0.000*
Schooling * Potential experience	-	-0.0001	-	-0.0013**
	-	*0.0007*	-	*0.0005*
Number of observations	34,485	34,485	13,095	13,095
R^2	0.1288	0.1288	0.3707	0.3714

Notes: The dependent variables used are: Annual surplus (for self-employed) and total wage income (for managers). Potential experience is calculated as: Age minus years of schooling minus 6. All regressions include the following variables as additional controls: Male (dummy), married (dummy), city (dummy), and immigrant (dummy). Columns (1) and (2) also include a dummy for an assisting spouse. A full set of estimation results can be found in Table A2 in the Appendix. Robust standard errors in italics. ** = significant at 1% level; * = significant at 5% level.

Table 5: Effects of Schooling and Wage-Work Experience for Entrepreneurs, Robustness Checks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Baseline specification from Table 3	With X^2, S^2, X^3, S^3 included	With X^2, S^2, X^3, S^3, X^4, S^4 included	With dummies for education and experience	Persons aged < 15 in 1980	Without immigrants	Employers	Non-employers	Experience in full-time equivalents
Self-employed:									
Schooling * Wage-work experience	0.0032**	0.0030**	0.0029**	0.0029**	0.0028**	*0.0035***	0.0035**	0.0028**	0.0028**
	0.0006	*0.0006*	*0.0006*	*0.0006*	*0.0009*	*0.0008*	*0.0010*	*0.0007*	*0.0007*
Number of observations	34,485	34,485	34,485	34,485	20,812	30,457	14,177	20,308	34,485
R^2	0.1908	0.1925	0.1931	0.1934	0.1840	0.1773	0.1617	0.1637	0.1882
Managers:									
Schooling * Wage-work experience	0.0027**	0.0028**	0.0026**	0.0026**	0.0023**	0.0029**			0.0012**
	0.0004	*0.0004*	*0.0004*	*0.0004*	*0.0006*	*0.0005*			*0.0004*
Number of observations	13,095	13,095	13,095	13,095	7,576	12,845			13,095
R^2	0.3797	0.3810	0.3831	0.3852	0.3660	0.3823			0.3775

Notes: The dependent variables used are: Annual surplus (for self-employed) and total wage income (for managers). All regressions include the following variables as additional controls: Age (in years), male (dummy), married (dummy), city (dummy), and immigrant (dummy; except in column 6). The regressions for self-employed also include a dummy for an assisting spouse and years of self-employment experience. A full set of estimation results is available from the authors upon request. Robust standard errors in italics. ** = significant at 1% level; * = significant at 5% level.

Table 6: Effects of Schooling and Wage-Work Experience for Entrepreneurs, Selected Years

	(1)	(2)	(3)	(4)
	Self-Employed		Managers	
	1998	2002	1998	2002
Schooling (in years)	-0.031**	-0.012	0.027**	0.005
	0.008	*0.007*	*0.010*	*0.008*
Wage-work experience (in years)	0.076**	0.091**	0.066**	0.048**
	0.011	*0.008*	*0.014*	*0.009*
Wage-work experience squared	-0.004**	-0.003**	-0.002**	-0.003**
	0.000	*0.000*	*0.001*	*0.000*
Schooling * Wage-work experience	0.0062**	0.0032**	0.0017**	0.0027**
	0.0008	*0.0006*	*0.0007*	*0.0004*
Number of observations	26,093	34,485	9,651	13,095
R^2	0.2278	0.1908	0.3705	0.3796

Notes: The dependent variables used are: Annual surplus (for self-employed) and total wage income (for managers). All regressions include the following variables as additional controls: Age (in years), male (dummy), married (dummy), city (dummy), and immigrant (dummy). Columns (1) and (2) also include a dummy for an assisting spouse and years of self-employment experience. A full set of estimation results is available from the authors upon request. Robust standard errors in italics. ** = significant at 1% level; * = significant at 5% level.

Table 7: Effects of Schooling and Wage-Work Experience for Entrepreneurs, Decomposed Experience

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Managers			Self-Employed		
Schooling * Wage-work experience	0.0027**			0.0032**			0.0040**
	0.0004			*0.0006*			*0.0006*
Schooling * Non-managerial experience		0.0031**	0.0027**		0.0032**	0.0031**	
		0.0004	*0.0004*		*0.0007*	*0.0006*	
Schooling * Managerial experience			0.0019*			0.0110	
			0.0008			*0.0087*	
Schooling * Self-employment experience							0.0019*
							0.0009
F-test interaction terms are equal			0.97			0.82	5.83
p-value for F-test			0.326			0.364	0.016
Number of observations	13,095	13,095	13,095	34,485	34,485	34,485	34,485
R^2	0.3796	0.3700	0.3807	0.1908	0.1904	0.1908	0.1990

Notes: The dependent variables used are: Annual surplus (for self-employed) and total wage income (for managers). All regressions include the following variables as additional controls: Age (in years), male (dummy), married (dummy), city (dummy), and immigrant (dummy). Columns (1) and (2) also include a dummy for an assisting spouse and years of self-employment experience. A full set of estimation results is available from the authors upon request. Robust standard errors in italics. ** = significant at 1% level; * = significant at 5% level.

Table 8: Effects of Schooling and Wage-Work Experience for Managers, Fixed Effects

	(1)	(2)	(3)
	Managers		
Schooling (in years)	0.046**	-0.008	-
	0.010	*0.012*	-
Wage-work experience (in years)	0.249**	0.198**	0.196**
	0.027	*0.028*	*0.010*
Wage-work experience squared	-0.002**	-0.002**	-0.002**
	0.000	*0.000*	*0.000*
Schooling * Wage-work experience	-	0.0038**	0.0044**
	-	*0.0003*	*0.0003*
Number of observations	65,634	65,634	64,963
Number of individuals	18,146	18,146	17,970
R^2 (within)	0.3085	0.3134	0.3136

Notes: Estimations are based on a panel of managers for the years 1996-2002. Column 3 excludes individuals who change their level of schooling in the period 1996-2002. The dependent variable used is annual surplus. All regressions include the following variables as additional controls: Married (dummy), city (dummy), years (dummies) and individual fixed effects. A full set of estimation results is available from the authors upon request. Robust standard errors in italics. ** = significant at 1% level; * = significant at 5% level.

Table 9: Effects of Schooling and Experience for Wage Workers

	(1)	(2)	(3)
	Wage workers		
Schooling (in years)	0.064**	0.094**	-
	0.003	*0.001*	
Wage-work experience (in years)	0.186**	0.209**	-
	0.005	*0.001*	
Wage-work experience squared	-0.005**	-0.005**	-
	0.000	*0.000*	
Schooling * Wage-work experience	-	-0.0023**	-0.0004**
	-	*0.0001*	*0.0001*
Number of observations	708,160	708,160	708,160
R^2	0.5565	0.5576	0.5687

Notes: The dependent variable used is total wage income. All regressions include the following variables as additional controls: Age (in years), male (dummy), married (dummy), city (dummy), and immigrant (dummy). In column 3, a full set of dummies for the different levels of schooling and experience are also included. Managers and individuals with previous self-employment experience have been excluded. A full set of estimation results can be found in Table A3 in the Appendix. Robust standard errors in italics. ** = significant at 1% level; * = significant at 5% level.

Table A1: Returns to Schooling and Wage-Work Experience for Self-Employed and Managers

	(1)	(2)	(3)	(4)
	Self-Employed		Managers	
Schooling (in years)	0.019**	-0.012	0.0521**	0.005
	0.003	*0.007*	*0.002*	*0.008*
Wage-work experience (in years)	0.128**	0.091**	0.0835**	0.048**
	0.005	*0.008*	*0.007*	*0.009*
Wage-work experience squared	-0.003**	-0.003**	-0.002**	-0.002**
	0.000	*0.000*	*0.000*	*0.000*
Schooling * Wage-work experience	-	0.0032**	-	0.0027**
		0.0006	-	*0.0004*
Self-employment experience (in years)	0.112**	0.111**	-	-
	0.002	*0.002*	-	-
Age (in years)	-0.007**	-0.006**	0.03**	0.032**
	0.002	*0.002*	*0.001*	*0.001*
Male (dummy)	0.256**	0.259**	0.24**	0.24**
	0.015	*0.015*	*0.009*	*0.009*
Married (dummy)	0.168**	0.168**	0.052**	0.056**
	0.014	*0.014*	*0.010*	*0.010*
Immigrant (dummy)	0.153**	0.145**	0.134**	0.131**
	0.026	*0.026*	*0.035*	*0.035*
City (dummy)	-0.028*	-0.031**	0.129**	0.126**
	0.012	*0.012*	*0.008*	*0.008*
Assisting spouse (dummy)	0.521**	0.522**	-	-
	0.026	*0.026*	-	-
Constant	10.207**	10.546**	10.084**	10.636**
	0.068	*0.096*	*0.063*	*0.12*
Number of observations	34,485	34,485	13,095	13,095
R^2	0.1899	0.1908	0.3763	0.3796

Notes: The dependent variables used are: Annual surplus (for self-employed) and total wage income (for managers). The regressions include the following variables as additional controls: Age (in years), male (dummy), married (dummy), city (dummy), and immigrant (dummy). Columns (1) and (2) also include a dummy for an assisting spouse and years of self-employment experience. Robust standard errors in italics. ** = significant at 1% level; * = significant at 5% level.

Table A2: Returns to Schooling and Potential Experience

	(1)	(2)	(3)	(4)
	Self-Employed		Managers	
Schooling (in years)	0.039**	0.041**	0.0845**	0.102**
	0.003	*0.012*	*0.002*	*0.007*
Potential experience (in years)	0.191**	0.193**	0.111**	0.135**
	0.007	*0.014*	*0.005*	*0.010*
Potential experience squared	-0.005**	-0.005**	-0.002**	-0.003**
	0.000	*0.000*	*0.000*	*0.000*
Schooling * Potential experience	-	-0.0001	-	-0.0013**
	-	*0.0007*	-	*0.0005*
Male (dummy)	0.427**	0.427**	0.256**	0.257**
	0.015	*0.015*	*0.009*	*0.009*
Married (dummy)	0.200**	0.200**	0.055**	0.052**
	0.014	*0.014*	*0.010*	*0.010*
Immigrant (dummy)	-0.496**	-0.496**	-0.055	-0.054
	0.020	*0.197*	*0.033*	*0.033*
City (dummy)	-0.066**	-0.066**	0.126**	0.127**
	0.013	*0.013*	*0.008*	*0.008*
Assisting spouse (dummy)	0.625**	0.625**	-	-
	0.026	*0.026*	-	-
Constant	9.482**	9.461**	10.378**	10.104**
	0.072	*0.173*	*0.041*	*0.110*
Number of observations	34,485	34,485	13,095	13,095
R^2	0.1288	0.1288	0.3707	0.3714

Notes: The dependent variables used are: Annual surplus (for self-employed) and total wage income (for managers). Potential experience is calculated as: Age minus years of schooling minus 6. All regressions include the following variables as additional controls: Male (dummy), married (dummy), city (dummy), and immigrant (dummy). Columns (1) and (2) also include a dummy for an assisting spouse. Robust standard errors in italics. ** = significant at 1% level; * = significant at 5% level.

Table A3: Returns to Schooling and Experience for Wage Workers

	(1)	(2)	(3)
	Wage workers		
Schooling (in years)	0.064**	0.094**	-
	0.003	*0.001*	
Work experience (in years)	0.186**	0.209**	-
	0.005	*0.001*	
Work experience squared	-0.005**	-0.005**	-
	0.000	*0.000*	
Schooling * Work experience	-	-0.0023**	-0.0004**
	-	*0.0001*	*0.0001*
Age (in years)	0.025**	0.023**	0.025**
	0.000	*0.000*	*0.000*
Male (dummy)	0.277**	0.277**	0.274**
	0.001	*0.001*	*0.001*
Married (dummy)	0.118**	0.116**	0.121**
	0.002	*0.002*	*0.002*
Immigrant (dummy)	0.205**	0.203**	0.202**
	0.004	*0.004*	*0.004*
City (dummy)	0.019**	0.02**	0.016**
	0.001	*0.001*	*0.001*
Constant	9.107**	8.826**	11.659**
	0.005	*0.010*	*0.024*
Number of observations	708,160	708,160	708,160
R^2	0.5565	0.5576	0.5687

Notes: The dependent variable used is total wage income. All regressions include the following variables as additional controls: Age (in years), male (dummy), married (dummy), city (dummy), and immigrant (dummy). In column 3, a full set of dummies for the different levels of schooling and experience are also included. Managers and individuals with previous self-employment experience have been excluded. Robust standard errors in italics. ** = significant at 1% level; * = significant at 5% level.

Figure 1: Earnings as a Function of Wage-Work Experience, Self-Employed and Managers